Bonneville Power Administration

THE BRIGHT WAY TO HEAT WATER™

GENERAL AND TECHNICAL SPECIFICATIONS for RESIDENTIAL SUMMER SEASONAL SOLAR POOL HEATING SYSTEMS

REVISED VERSION - 5/11/04

1. GENERAL PROGRAM SPECIFICATIONS

1.1. The solar pool heater (SPH) must be installed at a residence with electric service provided by [UTILITY NAME].

1.2. The participating customer must be the owner of the property or the owner's legally assigned representative.

1.3. The swimming pool must be electrically heated.

1.4. Only solar pool heaters determined eligible by BONNEVILLE qualify for the Program. Owner-built systems do not qualify. Additions to existing systems may qualify with [Utility Name] prior approval, and providing the entire system meets the general and technical specifications for solar pool heating systems.

1.5 The eligible solar pool heater must be purchased from a contractor-determined eligible by [UTILITY NAME] to participate in the program.

1.6. The installed SPH must be inspected by a [UTILITY NAME] representative to determine compliance with all program requirements.

2. GENERAL EQUIPMENT SPECIFICATIONS

2.1. Equipment and systems must undergo a technical review by BONNEVILLE to be determined eligible for the Program.

2.2. Solar pool heating collectors shall be of the copolymer plastic type, carry a minimum 10-year full warranty, and be certified by the Florida Solar Energy Center.

2.3. Eligible solar pool heating systems shall incorporate freeze protection strategies that:

a. Are approved by BONNEVILLE during qualification of each system type,

b. Possess demonstrated or theoretical reliability in weather conditions common to the BONNEVILLE service territory,

c. Result in no lost electrical energy due to circulation of heated water during cold winter conditions, and

d. Incorporate valves to facilitate manual draining of the collectors and pipes prior to freezing weather conditions.

2.4. Equipment and installation shall comply with all applicable building, plumbing, and electrical codes. If applicable, building permits shall be procured.

2.5. All equipment and materials used in this program shall be installed according to manufacturers' specifications, those included in this document, SRCC OG-400 Standards and any others required by BONNEVILLE. BONNEVILLE reserves the right to require compliance with installation specifications that may exceed or differ from those of a manufacturer and/or SRCC.

3. INSTALLATION SPECIFICATIONS

A. Consumer Documents

1. *When applicable, customer has received building permit for the system installation.*

   Contractor shall secure all Building Permits required by law for the installation of a solar pool heating system and arrange or have the customer arrange for all required permit inspections.

2. *Customer has received contractor's installation and manufacturer's component warranties.*

   Contractor shall provide customer with a written warranty stating the equipment and installation will be free from all defects in workmanship and materials for at least two years from the date of final approval by [UTILITY NAME]. Warranty shall include all labor for any repairs within the warranty

period. Manufacturers' component and material warranties shall be supplied to customer and may be used to satisfy part of this warranty requirement.

3. *Customer has received an owner's manual and complete operating instructions*.

   Contractor shall provide customer with a comprehensive owner's manual for the system, including detailed operation and maintenance instructions to help ensure effective and persistent system operation.

4. *Monitoring/maintenance instructions per [UTILITY NAME] specifications are plainly mounted/displayed*.

   Monitoring and maintenance instructions, as approved by [UTILITY NAME] for each SPH type, shall be mounted in a plainly visible location near the pool mechanical equipment. These instructions shall clearly include:
   a. How to monitor system performance.
   b. Description and recommended frequency of maintenance.
   c. Diagram of system noting location of valves and monitoring devices.
   d. How to drain the system to prevent freezing in winter.
   e. What to do and who to call in an emergency and when the system needs maintenance or repairs.

B. Auxiliary Pool Heater

1. *Auxiliary pool heater is electric.*

   The auxiliary pool heater shall be electric.

C. Equipment and Installation

General

1. *The swimming pool is equipped with a pool cover*.

   The swimming pool shall be equipped with a pool cover that covers the entire pool surface. It is recommended the cover be the clear bubble type to maximize passive solar gains to the pool when the pool is covered during the day. Acceptable alternatives are insulating foam sheet-type, rubberized canvas, or opaque vinyl covers.

2. All solar system components are new (not used).

To ensure customer's warranty protection for the equipment and installation and to ensure system reliability and performance, only new system components and materials shall be utilized.

3. *System operates properly*.

System shall be fully operational according to its design.

4. *All system components are covered for protection from the weather.*

All related solar system components (excluding collectors and piping) shall be adequately protected from damage and degradation due to weather and sunlight. At a minimum, all solar system control components shall be protected from overhead precipitation and direct sunlight by a permanent weatherproof awning, lean-to, or shed. It is recommended the components be located in a totally enclosed weatherproof space.

5. *All system components are located to allow access, are adequately protected, and do not interfere with pool maintenance functions.*

All solar system components shall be installed in a configuration and manner that shall allow room for their servicing and/or replacement, protect them from any incidental damage, and avoid any interference with maintenance or replacement of any of the existing pool equipment (pumps, filters, chlorinators, heaters, etc.).

6. *Monitoring devices are installed to be easily visible*.

All monitoring gauges and valves in the system must be installed to allow easy access to determine that system is functioning correctly.

7. *Any building insulation (attic, floor, wall), disturbed due to system installation, is restored to previous condition.*

To preserve pre-existing building insulation levels, contractor shall re-fluff, replace, or re-attach in a workmanlike manner, any existing insulation and its support that was disturbed during system installation. It is recommended that the contractor document any pre-existing or other damage, not due to the solar installation, and submit it to both the customer and [UTILITY NAME].

Collector Location, Orientation, Mounting and Plumbing

8. *Collector location has PSF of 0.85 or better, as calculated from lowest edge of the collector(s), or PSF of .60 or better if ALL shading exists below the Mar 21 - Sep 21 sun line on the BONNEVILLE sunchart.*

   The location of solar collectors shall have adequate exposure to sunlight. The collector location must have the minimum Prime Solar Fraction (PSF) of .85 or better within the solar window of 8:00 a.m. to 4:00 p.m., as calculated from the middle of the lowest edge of the collector(s). This shall be determined by the contractor by completing a BONNEVILLE sunchart prior to installation and verified by [UTILITY NAME] at the time of inspection. Alternatively, the collector location may have a PSF of .60 or better if ALL shading exists below the Mar 21 - Sep 21 sun line on the BONNEVILLE sunchart.

9. *Collectors are oriented within 40 degrees E or W of due south with a tilt angle of 10 to 35 degrees; or 41 to 90 degrees W, roof pitch of 4/12 or less, and with a tilt angle of 10 to 20 degrees*.

   To ensure adequate exposure to average incident solar radiation, the solar collectors must be oriented within 40 degrees E or W of due south with a tilt angle of 10 to 35 degrees; or within 41 to 90 degrees W on a roof with a pitch of 4/12 or less, and with a tilt angle of 10 to 20 degrees, or, if multiple banks of collectors, a combination of these orientations and tilts. East facing collectors shall not be considered acceptable.

10. *Collector headers are horizontal or slightly tilted toward the inlet.*

    To allow pool water to drain properly from the collectors, the collector headers shall be mounted horizontally. If any slight tilt in the header run is desired or necessitated, the pitch shall be toward the inlet. Header orientation parallel to roof slope (i.e., riser tubes oriented horizontally) is not allowed. It is recommended the piping between collectors and drain valves be pitched a minimum 1/8 inch per foot.

11. *Collector rows are plumbed so pool water enters a lower corner and exits the opposite upper corner of each row.*

    To facilitate proper solar heating, each row of solar collectors shall be plumbed to cause the pool water to flow diagonally upward through the collectors, i.e., the water enters a lower corner of the row of collectors and exits from the opposite upper corner of the row of collectors to the pool. For optimal system efficiency, it is recommended that the pool water supply piping be connected to the farthest lower collector inlet header. This keeps the solar heated water return line as short as possible, reducing heat loss.

12. *If system has multiple rows of collectors, all rows are plumbed in parallel and if possible the plumbing from all individual rows returns to a common high point before final return to the pool.*

    To ensure all collectors in the system receive a proportionate share of water volume and flow rate thereby producing optimal solar heating, all rows of collectors shall be plumbed in parallel and if possible the hot water return from each row shall be plumbed to a common high point before final return to the pool. In some configurations, e.g. multiple rows of collectors on racks, one behind the other ("sawtooth" configuration), a common high point may not be possible or practical.

13. *If system has multiple rows of collectors, a means for balancing flow rate is provided and the system flow rate is balanced.*

    If the solar pool heating system has multiple rows of collectors, and the different rows are mounted at different heights or on different roof areas or otherwise at different distances from the pool pump, and/or if there are different numbers of collectors in the rows, flow rates through the different rows will potentially be unbalanced, which can lower the heat gathering effectiveness of the overall system.

    To facilitate effective solar heating, if there are multiple rows of collectors a means for balancing the flow rate through the rows shall be provided, and the system flow rate shall be balanced.

    One method to achieve balanced flow rates is to install a ball valve on the inlet to each row of collectors and a well-type thermometer fitting and thermometer on the outlet from each row of collectors. While the system is in solar heating operation mode, flow to each row of collectors is regulated with the ball valve, and system flow rate is balanced when the outlet temperature from each row is equal. To avoid tampering and/or damage to these balancing components, it is recommended that when the flow rate has been balanced, the ball valve positions are marked and (if possible) the handles from the ball valves and the thermometers are removed and stored for future use to re-balance the system.

    An alternative method uses ball valves as above, and instead of using in line well-type thermometers, a laser thermometer is used to measure temperature at the hot outlet of each collector row. Again, system flow rate is balanced when the outlet temperature from each row is equal.

Other methods of balancing system flow rate are possible, such as varying pipe size and length, and are typically utilized for larger, commercial sized pools and require pre-engineering.

14. *Collector mounting is per manufacturers specifications*.

    To comply with warranty provision and ensure long-term integrity of the system, collectors shall be mounted according to manufacturers specifications and any BONNEVILLE requirements specific to the system.

15. *Framework will resist deterioration.*

    To maintain structural integrity of the support system and the collectors, all mounting components, racking materials, and collector framework shall resist deterioration. Wood shall be pressure treated and steel shall be primed and painted to prevent rust. Joiners and fasteners shall be of similar, non-reactive metals of adequate strength.

16. *Corrosion between dissimilar metals has been avoided in all structural components and mounting hardware.*

    Like or compatible metals shall be used to prevent corrosion between dissimilar metals.

17. *Collectors that use a protruding flange connection at the headers have flashing installed between each flange and roof surface.*

    To prevent deterioration of the roof surface during expansion and contraction of the collectors, collectors that use a protruding flange connection at the headers shall have properly installed flashing between each header joint flange connection and the roof surface.

18. *All roof penetrations are permanently sealed*.

    To prevent roof damage and water leaks, all roof penetrations shall be permanently sealed. Pipes shall be run through properly installed roof jacks. Lag screw and spanner bolt penetrations shall be sealed in and around the holes and over the entire fastening assembly with a 20-year plus rated sealant compatible with the roofing material.

19. *Collectors have 2 or 3 hold-down straps across the width of each collector.*

To prevent uplift due to high winds and to ensure collector array stability, all collectors shall have hold-down straps as supplied by the collector manufacturer installed across each row of collectors and secured between each collector in accordance to manufacturers recommendations.

A minimum of two (2) straps is required, and three (3) is recommended. The lower strap shall be located 16 inches above the lower header of each collector row. If 2 straps are used, the upper strap shall be located an equal distance between the upper header and the lower strap for each collector row. If 3 straps are used, the upper and middle straps shall be spaced apart equally between the upper header and the lower strap for each collector row. Vinyl covered metallic straps are recommended. Any non-metallic straps shall be run continuously across each row of collectors (i.e., no splices between collectors are allowed) and shall be knotted at the ends to keep them from pulling out over time.

System Plumbing/Piping

20. *Piping between collectors and the pool mechanical system is schedule 40 PVC material and is a minimum diameter 1.5" up to 40 gallons/minute and 2" up to 80 gallons/minute.*

To reduce friction losses in the plumbing, minimize the load on the pool pump and achieve adequate system flow, the piping between the collectors and the pool mechanical system shall be schedule 40 PVC material and is a minimum diameter 1.5" up to 40 gallons/minute and 2" up to 80 gallons/minute.

21. *System flow rate is compatible with total number and size of collector panels.*

To achieve optimum solar heating results, the collector panels shall have adequate flow rate through each panel. Follow manufacturers recommendations or these general guidelines:

Collector size	Minimum flow rate*	Maximum flow rate*
4' x 12'	3.0 gpm	10.0 gpm
4' x 10'	2.5 gpm	10.0 gpm
4' x 8'	2.5 gpm	10.0 gpm

* Flow rates are per panel.

For example, using the general guidelines, a simple system with 8, 4'x10' collectors needs to have a total system flow rate between the minimum of 20 gpm (8 x 2.5 gpm), and the maximum of 80 gpm (8 x 10.0 gpm).

22. *Piping runs are adequately supported*.

To ensure correct system operation and to prevent damage due to trapped pool water in the pipes, piping runs shall be well supported using appropriate materials.

23. *There are no leaks in the system plumbing.*

All plumbing and connections are installed properly to ensure no fluid leakage in the system.

Valves, Controls, and Meters

24. *Isolation ball valves are installed enabling bypass of solar collection loop.*

To ensure the solar collection loop can be isolated from the backup pool heater in an emergency or for servicing the system, and to protect solar loop components from freezing if pool circulation system is ever operated during potential freezing periods (either to heat the pool with an auxiliary heater or as a means of protecting the circulation equipment), a ball valve shall be installed on each the supply and return collector piping to enable bypass of the solar collection loop.

25. *Drain valves are installed on solar side of isolation valves at the lowest point on the collector inlet and outlet piping.*

    To ensure complete drainage of pool water from the collectors and piping prior to freezing conditions, manual drain valves shall be installed on the solar side of the isolation ball valves and located at the lowest point on both the inlet and outlet piping to the collectors.

26. *Flow meter is provided*.

    To enable monitoring of the water flow rate in the system, a flow meter and any associated plumbing required for its proper operation shall be installed in an easily visible location.

    To minimize the need to maintain or replace the flow meter, it is possible to provide a means of removing the flow meter and plugging its port in the piping when it is not in use to monitor the flow rate. If this is done, the plug in the piping shall be water tight and able to withstand system-operating pressures.

27. *A thermometer is installed in the return line from the collectors and prior to the auxiliary pool heater.*

    To monitor the temperature of the solar pre-heated water, a thermometer shall be installed between the solar collectors and the auxiliary pool heater.

28. *Vacuum relief valve(s) is/are installed on the upper collector header(s).*

    To allow a break in vacuum, thus enabling water in the collectors to return to the pool when the motorized valve has diverted the flow past the collector array, a vacuum relief valve shall be installed at the upper collector header opposite the hot water return outlet. If the hot water return lines from multiple rows of collectors are plumbed to a common high point before final return to the pool (Specification 3.C.12.), only one vacuum relief valve is required at the common high point. If multiple rows of collectors are mounted on racks in sawtooth configuration, and the upper headers are not connected with common pipe, then a separate vacuum relief valve shall be installed for each row of collectors.

29. *A motorized three-way valve is installed after the pool filter in the supply piping to the collectors and is powered by a differential temperature controller.*

    To allow the solar system to be operated only when the panels have reached sufficient temperature to add heat to the pool, and avoid cooling the pool during periods of insufficient sun, a motorized three-way valve powered by a differential temperature controller shall be installed. To ensure proper operation and drainage of the collectors and piping, the 3-way valve shall be installed on the supply piping to the collectors and after the pool filter. (The common port of the 3-way valve shall connect to the filter outlet.)

30. *A check valve is installed between filter and 3-way valve.*

    A check valve shall be installed between the filter and the solar 3-way valve to prevent any backwash from the filter to the pool when the solar collectors drain. It is recommended the check valve be of the clear plastic type to enable visible verification of its function. It is also recommended to use a check valve with unions to facilitate servicing and/or replacement of the valve.

31. *Controller is set for desired pool temperature, mounted within 6 ft. of the pool mechanical equipment and is hard-wired or plugged into nearest outlet with the wiring securely attached. If plugged into an outlet, the plug is labeled per BONNEVILLE specifications.*

    To ensure correct system operation the differential controller shall be set for the desired pool temperature high-limit. To allow for monitoring and servicing of the system, the controller shall be mounted within 6 ft. of the motorized 3-way valve, hard-wired (recommended) or plugged into nearest outlet with the wiring securely attached to parts of the system or adjacent walls or ceiling. If the controller is plugged into an outlet, the plug shall be labeled per BONNEVILLE specifications.

32. *Sensors are placed correctly and attached securely.*

    To ensure accurate operation of the automatic controls, sensors shall be placed correctly and attached securely. The solar sensor shall be exposed to the same environment (sun angle, orientation, wind, etc.) as the collectors, ideally next to and near the top of the collectors. The pool water temperature sensor shall be installed in direct contact with the pool water, as provided or recommended by the controller manufacturer, and shall be installed after the pool filter and before the motorized 3-way valve.

33. *Sensor wire is rated for outdoor use, has good connections, and is protected from weather and high temperatures.*

    To ensure correct system operation, the sensor wiring connections shall be permanently joined using crimp-type connectors and then sealed with silicone sealant. The wire shall not come in contact with hot piping or metals, shall be UV protected and rated for exterior use, and shall be protected (as much as possible) from weather and high temperatures. Any sensor wire to be run underground shall be continuous (no splices) and shall be rated for direct burial or run within conduit.

34. *All valves, gauges and instruments are labeled per BONNEVILLE specifications.*

    To identify and describe the purpose and operation of specific devices in the system, all valves, gauges, and instruments near the pool mechanical equipment shall be labeled. Permanent tags shall be used incorporating BONNEVILLE approved descriptions that include the following:

    a. Name/identification of the valve, gauge, or instrument.
    b. Purpose of the valve, gauge, or instrument.
    c. Operation of the valve, gauge, or instrument.

4. REFERENCES

- Swimming Pool Solar Heating Systems Installation Manuals for:

  AquaSol
  Aquatherm
  FAFCO
  Heliocol
  Solar Industries
  Sunstar

- Manual for A Solar Thermal Seminar, California Solar Industries Association (1991)

- Solar Heating for Swimming Pools, Florida Conservation Foundation (1980)

- Pool Collector Thermal Performance Ratings, Florida Solar Energy Center